

Oceanography Part -2



Heat Budgets Of The Ocean

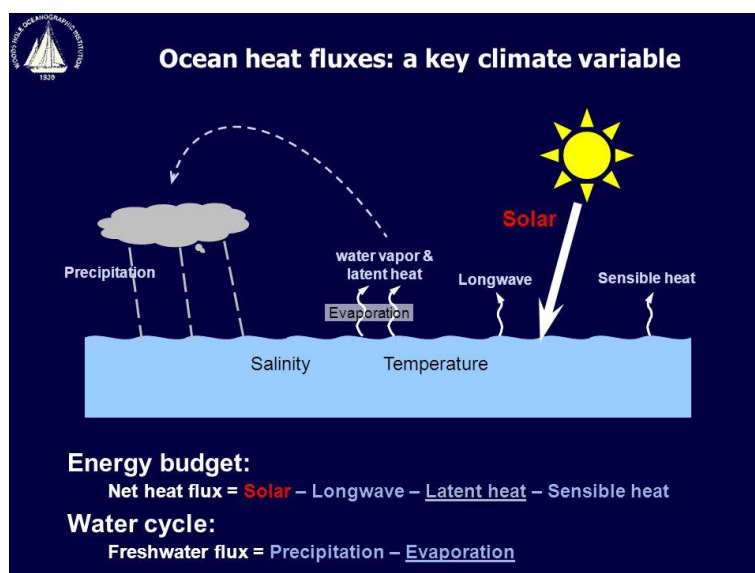
- If we ignore the temperature rise phenomenon due to climate change. Overall Ocean water temperature is nearly the same, it is not warming or cooling over time;
- That means the overall heat of the ocean remains the same that also means total incoming heat to ocean water from all the sources and outgoing heat from the ocean water is equal.
- The details of all the incoming or heat gains and outgoing heat or heat loss in the ocean in all forms; studied under the Heat Budget of the Ocean.

Ocean Heat Gains(Sources of Ocean Heat):

- Short wave radiation from Sun:
- 50 % of Sun Insolation is being absorbed by Ocean and land.
- The ocean is the largest heat collector from the Sun as Ocean covers 71 % of the earth's surface.
- Direct heating from Air
- Heat gains from Land
- Heat Gains from Earth interior
- Heat Gains from the biological process
- Heat gains from the friction of water molecules through the wave, current, etc.

Ocean Heat Loss:

- Heat transfer through evaporation:
- 51 % of input heat energy received in the ocean is used for evaporation.
- Surplus heat from the Equator is being transferred to the heat deficit region by the ocean current circulation system.
- Heat transfer to air
- Heat transfer to land
- Ocean Heat Budget= Ocean Heat Gains - Ocean Heat loss=0;



Ocean Currents:

- World Water Day – March 22
- The movements that occur in oceans are categorized as: waves, tides and currents.
- Ocean currents are streams of water(like river flow) flowing on the ocean surface in a definite direction.
- Waves are formed due to friction between wind and surface water layer. The stronger the wind, the bigger the wave. They die out quickly on reaching the shore or shallow waters.
- Horizontal currents arise mainly due to friction between wind and water. Rotation of earth, Coriolis force and differences in water level gradient also play a major role.
- Vertical currents arise mainly due to density differences caused by temperature and salinity changes.

Ocean currents are influenced by two types of forces namely:

- primary forces that initiate the movement of water;
- secondary forces that influence the currents to flow.

The primary forces that influence the currents are:

heating by solar energy;
wind;
gravity;
Coriolis force.

The secondary forces that influence the currents are:

Temperature difference;
Salinity difference

Primary Forces Responsible For Ocean Currents

Heating by Solar Energy:

Heating by solar energy causes the water to expand. Ocean water at equators is about 8 cm higher than the middle latitude level of the ocean. This creates a gradient to water flow down the slope.

The flow is normally from east to west.

Winds:

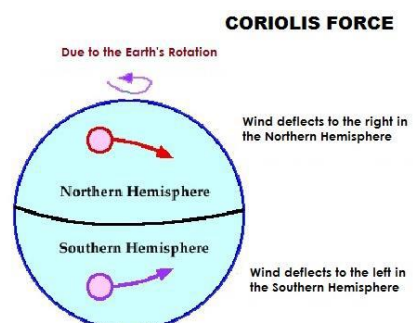
Winds create friction on the ocean surface between air and water that affects the movement of the ocean current.

Gravity:

Gravity tends to pull the water down and high saline cold water sinks in the bottom of the ocean.

Coriolis forces:

Coriolis forces intervene and cause water to move to the right in the northern hemisphere and left in the southern hemisphere.

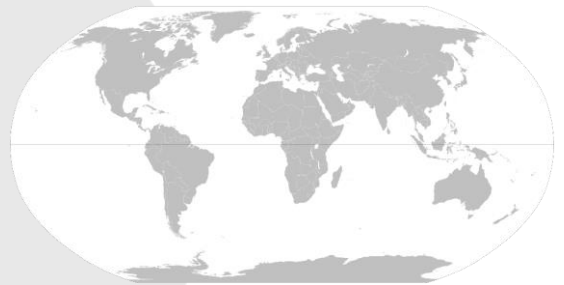


Secondary Forces Responsible For Ocean Currents

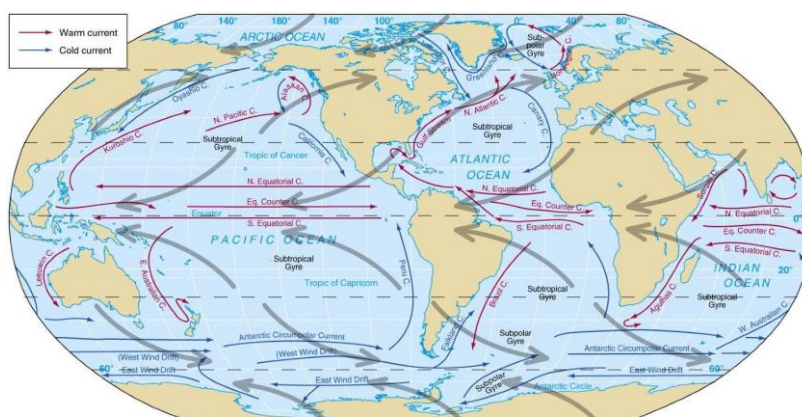
- Temperature difference and salinity difference are the secondary forces.
- Differences in water density affect vertical mobility of ocean currents (vertical currents).
- Water with high salinity is denser than water with low salinity and in the same way cold water is denser than warm water.
- Denser water tends to sink, while relatively lighter water tends to rise.
- Cold-water ocean currents occur when the cold water at the poles sinks and slowly moves towards the equator.
- Warm-water currents travel out from the equator along the surface, flowing towards the poles to replace the sinking cold water.

Types Of Ocean Currents

- **Based on depth**
- The ocean currents may be classified based on their depth as **surface currents and deep water currents**:
- surface currents constitute about 10 per cent of all the water in the ocean, these waters are the upper 400 m of the ocean;
- deep water currents make up the other 90 per cent of the ocean water. These waters move around the ocean basins due to variations in the density and gravity.



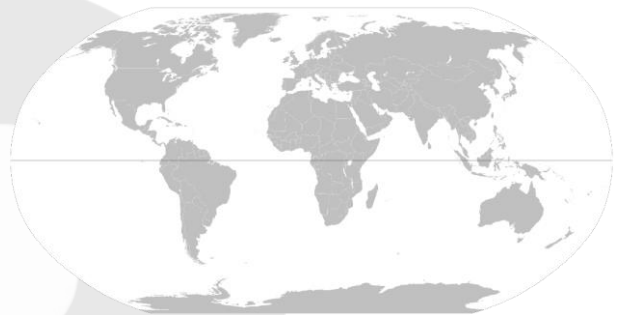
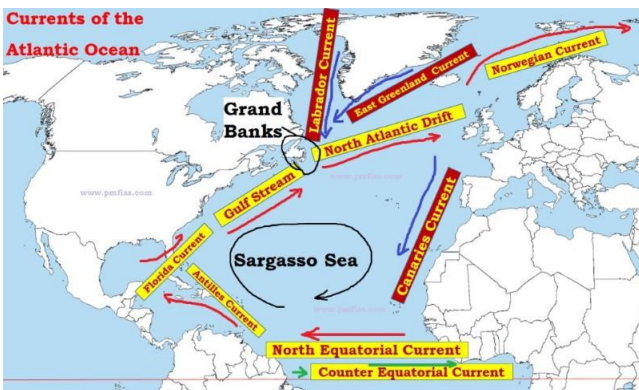
- **Based on temperature**
- Ocean currents are classified based on temperature: as **cold currents and warm currents**:
- Cold currents bring cold water into warm water areas [from high latitudes to low latitudes]. These currents are usually found on the west coast of the continents (currents flow in clockwise direction in northern hemisphere and in anti-clockwise direction in southern hemisphere)
- Warm currents bring warm water into cold water areas [low to high latitudes] and are usually observed on the east coast of continents in the low and middle latitudes (true in both hemispheres). In the northern hemisphere they are found on the west coasts of continents in high latitudes.



General Characteristics of Ocean Currents

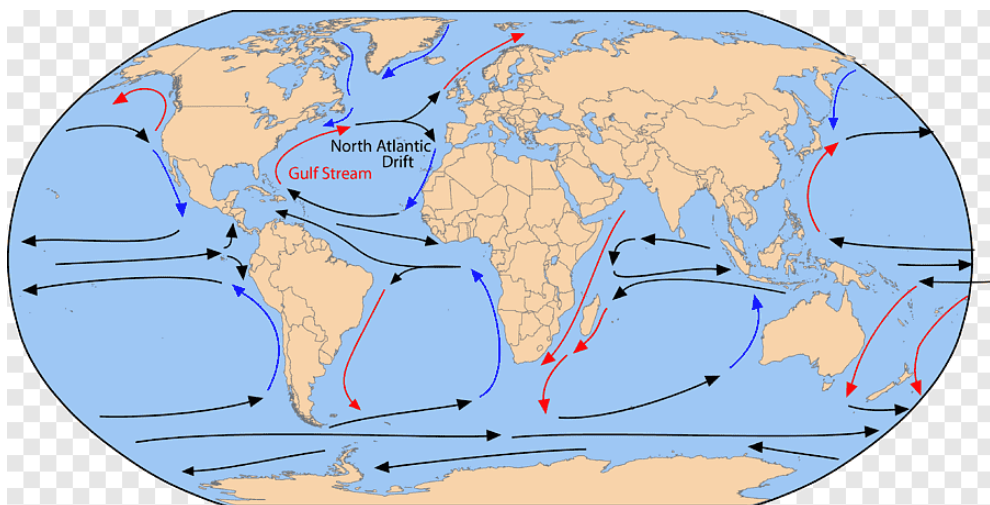
- The general movement of the currents in the northern hemisphere is clockwise and in the southern hemisphere, anti-clockwise.
- This is due to the Coriolis force which is a deflective force and follows Ferrel's law.
- Convergence: warm and cold currents meet.
- Divergence: a single current splits into multiple currents flowing in different directions.

Atlantic Ocean Currents

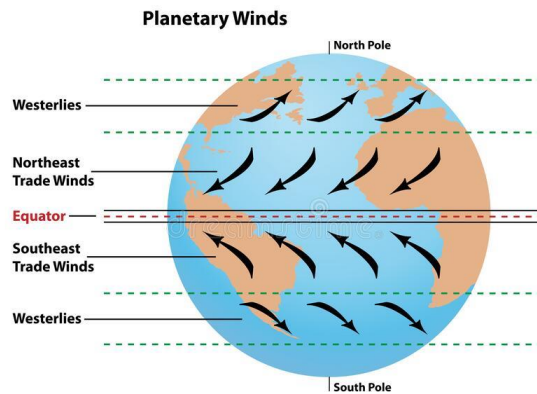


Gulf Stream and North Atlantic Drift

- Antilles current creates a current that flows out through the Strait of Florida as Florida current, which mixes with Antilles current from the south.
- This combined current moves along the east coast of USA and is known as the Florida current up to the Cape Hatteras and as the Gulf Stream beyond that.
- Near the Grand Banks, the Gulf Stream mixes with cold Labrador and East Greenland currents and flows eastward across the Atlantic as the North Atlantic Drift.
- Here, westerly movement of North Atlantic Drift is due to the influence of westerlies.

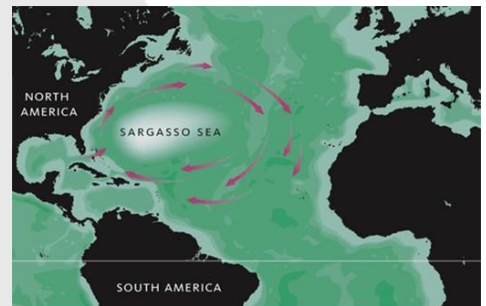


Norwegian current is very important as it keeps ocean to the north of Norway partly free from ice and also moderates the extremes of climate. It is because of this current, Russia is able to move cargo in summers through Arctic ocean (Barents Sea).



Sargasso Sea

- It is the only sea on Earth which has no coastline.
- It is bounded on the west by the Gulf Stream;
- north, by the North Atlantic Current;
- east, by the Canary Current; and
- south, by the North Atlantic Equatorial Current.

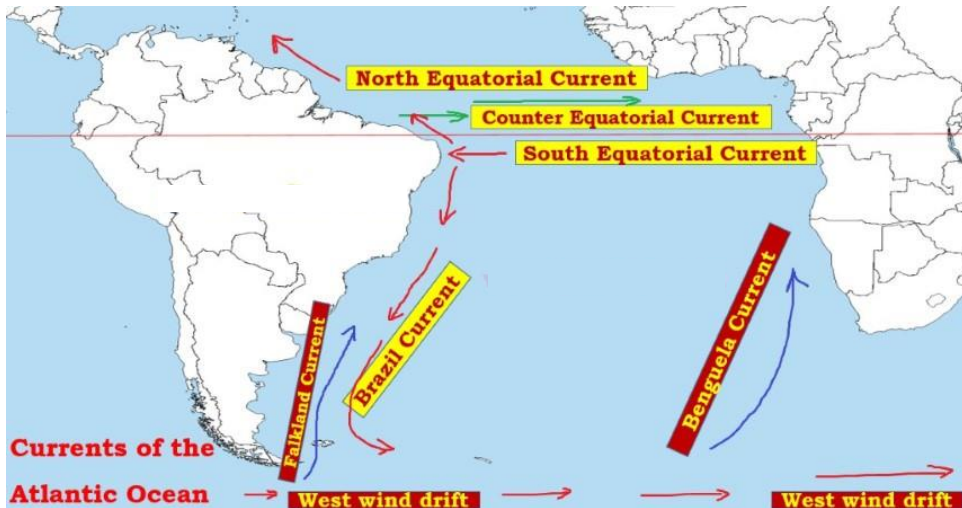


Grand Banks-Richest Fishing Grounds on Earth

- The two cold currents—East Greenland current and the Labrador current—flow from the Arctic Ocean into the Atlantic Ocean.
- The Labrador current flows along part of the east coast of Canada and meets the warm Gulf Stream.
- The confluence of these two currents, one hot and the other cold, produce the famous fogs around Newfoundland.
- As a result of mixing of cold and warm waters, one of the world's most important fishing grounds is created

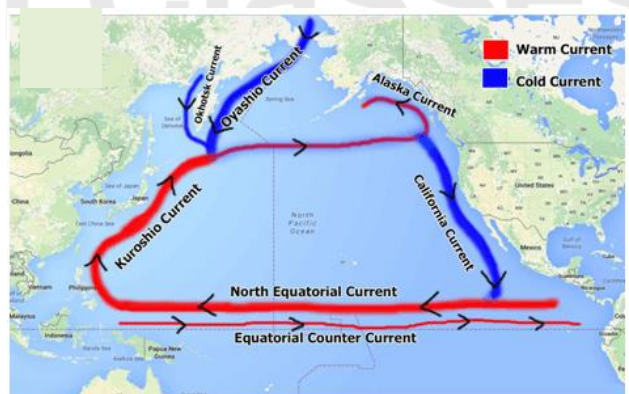
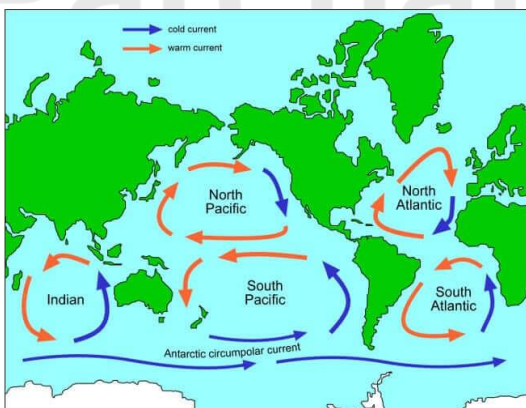


Brazil current



- In the South Atlantic Ocean, the south equatorial current, flowing from east to west, splits into two branches near Cape de Sao Roque (Brazil).
- The northern branch joins the north equatorial current (a part of it flows in Anatlles Current and other into Gulf of Mexico), whereas the southern branch turns southward and flows along the South American coast as the warm Brazil current.
- The south flowing Brazil current swings eastward at about latitude 35°S (due to westerlies) to join the West Wind Drift flowing from west to east.
- A small branch of West Wind Drift splits and flows between Argentinian coast and Falkland Islands and this current is called as Falkland cold current.
- A branch of the South Atlantic splits at the southern tip of Africa and flows along the west coast of South Africa as the cold Benguela current, which joins the south equatorial current to complete the circuit.

Pacific Ocean Currents



Pacific Ocean: Northern Hemisphere

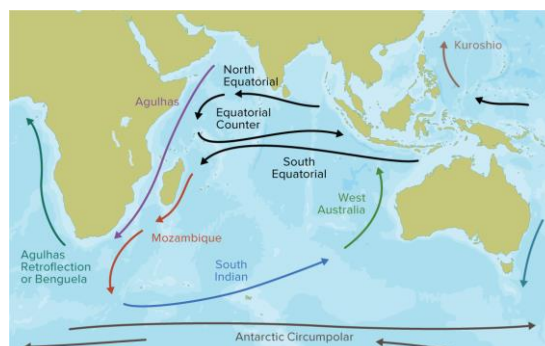
- The North Equatorial Current turns northward and flows along the Philippines Islands, Taiwan, and Japan to form the warm Kuro Shio or Kuro Siwo current.
- Later, a cold current called Oya Shio or Oya Siwo which flows along the eastern coast of the Kamchatka Peninsula merges with the Kuro Shio Current
- From the southeast coast of Japan, the Kuro Shio current comes under the influence of westerlies and flow right across the ocean as the North Pacific Current.
- After reaching the west coast of North America, it bifurcates into two branches: the northern branch flows anti-clockwise along the coast of Alaska as warm Alaska Current and the southern branch moves southward along the coast of California as the cold California Current.
- California Current eventually joins with the North Equatorial Current and completes the circuit.



Pacific Ocean: Southern Hemisphere

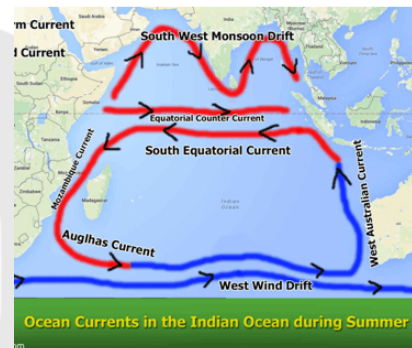
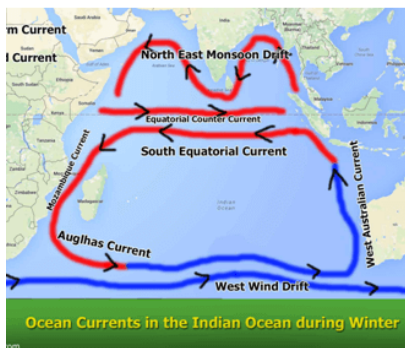
- In the South Pacific Ocean, the South Equatorial Current flows towards the west and turns southward as the East Australian Current.
- From Tasmania, it flows as the cold South Pacific Current from west to east and crosses the Pacific Ocean along with the West Wind Drift.
- On reaching the south-western coast of South America, it turns northward and flows as the cold Peru Current or Humbolt Current.
- The cold waters of the Peru Current are partially responsible for making the coast of northern Chile and western Peru with very scanty rainfall.
- Peru Current eventually joins with the South Equatorial Current and completes the circuit.

Indian Ocean Currents



Indian Ocean: Southern Hemisphere

- In the southern part, the South Equatorial Current which flows from east to west is strengthened by its corresponding current of the Pacific Ocean.
- It then turns southward along the coast of Mozambique in Africa.
- A part of this current moving in between the African mainland and Mozambique is called the warm Mozambique Current.
- After the confluence of these two parts, the current is called Agulhas Current.
- Agulhas Current merges with the West Wind Drift when it crosses the Indian Ocean.
- A branch of this merged current flows along the western coast of Australia as cold West Australian Current.
- It later joins with the South Equatorial Current to complete the circuit.



Indian Ocean: Northern Hemisphere During Winter

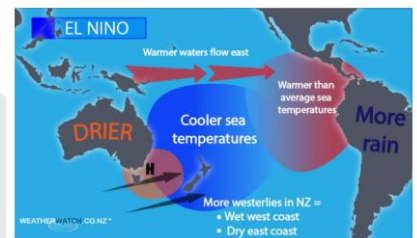
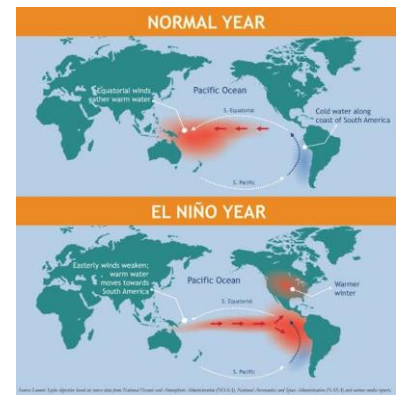
- During winter, Sri Lanka divides the currents of the Arabian Sea from those of the Bay of Bengal.
- The North-East Monsoon Drift flows westward just south of Sri Lanka with a countercurrent flow between it and the South Equatorial Current.
- During the winter season, in the northern section, the Bay of Bengal and the Arabian Sea are under the influence of North East Monsoon Winds.
- These North East Monsoon winds drive the waters of the Bay of Bengal and the Arabian Sea westward to circulate in an anti-clockwise direction.

Indian Ocean: Northern Hemisphere During Summer

- In summer, the northern part comes under the influence of the South West Monsoon.
- It results in an easterly movement of water in the Bay of Bengal and the Arabian Sea in a clockwise direction.
- This current is called the South West Monsoon Drift.
- In the Indian Ocean, the summer currents are more regular than those of the winter.

El Nino

- El Nino was first recognized by Peruvian fishermen off the coast of Peru as the appearance of unusually warm water.
- The Spanish immigrants called it El Nino, meaning “the little boy” in Spanish.
- The El Nino event is not a regular cycle, they are not predictable and occur irregularly at two- to seven-year intervals.
- When coastal waters become warmer in the eastern tropical Pacific (El Nino), the atmospheric pressure above the ocean decreases.
- Climatologists define these linked phenomena as El Nino-Southern Oscillation (ENSO).

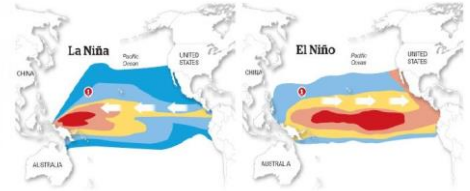


Impact of El Nino

- **Impact on Ocean:** El Nino also impacts ocean temperatures, the speed and strength of ocean currents, the health of coastal fisheries, and local weather from Australia to South America and beyond.
- **Increased Rainfall:** Convection above warmer surface waters brings increased precipitation.
- Rainfall increases drastically in South America, contributing to coastal flooding and erosion.
- **Diseases caused by Floods and Droughts:** Diseases thrive in communities devastated by natural hazards such as flood or drought.
- El Nino-related flooding is associated with increases in cholera, dengue, and malaria in some parts of the world, while drought can lead to wildfires that create respiratory problems.
- **In Western Pacific:** These winds push warm surface water towards the western Pacific, where it borders Asia and Australia.
- Due to the warm trade winds, the sea surface is normally about 0.5 meter higher and 4-5° F warmer in Indonesia than Ecuador.
- The westward movement of warmer waters causes cooler waters to rise up towards the surface on the coasts of Ecuador, Peru, and Chile. This process is known as upwelling.

La Nina

- La Nina means The Little Girl in Spanish. It is also sometimes called El Viejo, anti-El Nino, or simply "a cold event."
- La Nina event is observed when the water temperature in the Eastern Pacific gets comparatively colder than normal, as a consequence of which, there is a strong high pressure over the eastern equatorial Pacific.
- La Nina is characterized by lower-than-normal air pressure over the western Pacific. These low-pressure zones contribute to increased rainfall.



- However, strong La Nina events are associated with catastrophic floods in northern Australia.
- La Nina is also characterized by higher-than-normal pressure over the central and eastern Pacific.
- This results in decreased cloud production and rainfall in that region.
- Drier-than-normal conditions are observed along the west coast of tropical South America, the Gulf Coast of the United States, and the pampas region of southern South America.
- **La Nina in 2010**
- The 2010 La Nina event correlates with one of the worst floods in the history of Queensland, Australia.
- More than 10,000 people were forced to evacuate, and damage from the disaster was estimated at more than \$2 billion.

Impact of La Nina

- Stronger winds along the equatorial region, especially in the Pacific.
- Favourable conditions for hurricanes in the Caribbean and central Atlantic area.
- Greater instances of tornados in various states of the US.
- **South America:** La Nina causes drought in the South American countries of Peru and Ecuador.
- It usually has a positive impact on the fishing industry of western South America.
- **Western Pacific:** In the western Pacific, La Nina increases the potential for landfall in those areas most vulnerable to their effects, and especially into continental Asia and China.
- It also leads to heavy floods in Australia.

MCQ

Which of the following currents is not a warm current?

- (a) Florida Current
- (b) California Current
- (c) Brazilian Current
- (d) Mozambique Current

Which one of the following is not an Atlantic Ocean current?

- (a) Labrador Current
- (b) Gulf Stream
- (c) Somali Current
- (d) Benguela Current

1. Warm currents have a higher surface temperature.
2. These currents flow in the clockwise direction in the northern hemisphere.

Which of the given statements is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

In the Northern Hemisphere currents flow to the right of the wind direction while in the Southern Hemisphere, winds blow to the left. This happens due to:

- (a) Coriolis Effect
- (b) Temperature
- (c) Rotation of Earth
- (d) Salinity

Which of the following is a warm water current?

- (a) Benguela Current
- (b) Japan Current
- (c) Falkland Current
- (d) Canaries current

Question	Answer
1	b
2	c
3	c
4	a
5	b



Parcham Classes